FIBRIN:

ITS ORIGIN AND SOURCES OF DEVELOPMENT

IN THE ANIMAL ORGANISM;

VERITABLE FIBRIN BEING PROVED TO BE DERIVED
FROM ALBUMINOUS SUBSTANCES BY
THE AGENCY OF WATER.

BY

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The President of the
Royal College of Physicians.

Dear Sir May I have the honour of your acceptance and perusal of the enclosed series of Experimental Proofs of my Paper read before Section D of the British Association, and Published in their Annual Report, 1870, viz.: "*Fibrin derived from Albumen by the Agency of Water*"?—one of the most important subjects of enquiry of the present hour, the origin of Fibrin in the animal organism.

I have the honour to remain,

Yours most obediently,

JOHN GOODMAN, M.D.

This Paper was read before
Section D of the Brit. Assoc —
at Edinburgh - Aug. 1871
The entire series of Experiments —
in proof - were a great triumph —

ORIGIN OF FIBRIN.

THE author having read a Paper on this subject at the Liverpool meeting last year, which is published in the Report, has been since that period engaged in attempting to prove, by a long and complete series of experiments, the truth then set forth. The following is an epitome of the results arrived at:—

1. *Albumen, from the egg suspended in ropes in cold and pure water, and exposed for some little time to its influence, loses its character of Albumen, and assumes the nature, appearance, and constitution of Fibrin.*

Thus it coagulates independently of the application of heat, and becomes solid and insoluble—characteristics which distinguish Fibrin from all other analogous substances.—See Dr Miller's Organic Chemistry, Part III., page 800.

2. Under the microscope, which was used in all these experiments, when thus transformed by water, it *exactly resembles Blood Fibrin*, with the reactions, &c., of which it was constantly compared. So great was the resemblance that a medical gentleman from Manchester selected this substance under the microscope for the real genuine Blood Fibrin, in preference to a specimen of the latter substance itself.

3. *Intense affinities and formative qualities.*

Blood Fibrin, and especially this substance, differ from Albumen in possessing intense attractive powers and affinities, which appear to be the secret cause of the formative qualities of Fibrin; causing it to form, in definite lines, into rods and substances, &c., which evince the presence of a controlling constructive power, and enabling it to assume forms and grotesque figures, of which it might be said that nothing but vitality was wanting to endow them with the character of living beings. In several instances, the *Fibrin ab albumen*, as we will now call it, manifested decided electric attraction, for it was drawn aside and out of its perpendicular, in several instances, some ¼ inch or

so, by attractive influence towards a copper wire when raised from the water. On the other hand, Albumen presents itself as a homogeneous, motionless, and shapeless mass, and entirely destitute of these powers and characteristics.

4. Like Blood Fibrin, it was found to decompose *Peroxide of Hydrogen with effervescence*, whilst, as stated by Dr Miller (page 806), "Albumen produces no such effect."

Again, Dr Miller tells us that *neutral salts*, mixed with blood, on abstraction, prevent its coagulation. This we found to be the case with regard to this substance—even sea water prevented, in a great measure, the transformation.

Is Oxygen capable of effecting this change?

Dr Miller declares (page 807) that there is a great difference between the action of oxygen on Albumen and Fibrin. That the former, when exposed to oxygen, enclosed in a glass tube, over mercury, indicates scarcely any absorption of the gas and little or no carbonic anhydride is eliminated; but when coagulated Fibrin is exposed, *in a moist state*, to the air, it gradually absorbs oxygen, emits carbonic anhydride, and in a few days becomes putrid. I found that *Fibrin ab albumen* as well as *Blood Fibrin*, has a great affinity for oxygen, especially when moist and near decomposition, whilst *Albumen*, in ropes hung up in the atmosphere, remained entirely unchanged in its nature, save that it became a brittle rod.

In order to show that oxygen of the air takes no part in this transformation (in *Exp.* 102, 103), I found that the transformation of Albumen into Fibrin proceeded exactly similarly in two bottles, the one closed by a stopper, the other open to the atmosphere—no perceptible difference occurring between them for days, and even weeks.

In all these experiments, I have not discovered one instance in which oxygen has shown itself capable of effecting any change in albumen without the previous intervention of water.

There is, however, an experiment on record, as given by Dr Carpenter, in which Mr Smee is said to have produced a substance presenting numerous points of similarity to Fibrin, if not identical with it, by passing oxygen through defibrinated blood serum to which ordinary ov. albumen has been added, or through

albumen slightly acidified with acetic acid.—(See Dr Carpenter's Principles of Physiology, page 56.)

In these experiments, *pure albumen*, or *albumen alone*, was not employed. In the one case it was mixed with *blood serum*, and *perhaps with water*, of which we are not informed, and in the other, with acetic acid.

In the first experiment by Mr Smee the serum employed had been of course exposed to the agency of water in several instances in the animal organism, and therefore, even when defibrinated, as shown by Muller, *and mixed with water*, coagulates after passing a filter. In the other acetic acid was used, and the water which it contains was, we contend, sufficient to induce the change in question.

But there are no acetic or other strong acids in the lymphatics and lacteals in which Fibrin is at first seen to derive its origin, and therefore the latter experiment has nothing to do with the subject in hand.

I find, by experiment, that we have in blood serum always—

1. Already *formed Fibrin in solution ready to coagulate.*
2. Do., do., which will manifest itself on *exposure to the air.*
3. The remaining albumen, which is all capable of transformation by being *diluted with water.*

Exp. 99.—In order to prove or disprove Mr Smee's experiment as regards simple albumen itself, I exposed ov-albumen to a stream of oxygen in a glass tube for six hours, and afterwards for forty-eight hours to bubbles of the same still remaining in the Albumen. At the end of this time its transparency remained unaltered,—slightly more yellow—and the bubbles were somewhat diminished in size. There was no appearance, under the microscope, of any Fibrin having been formed. The Albumen was unchanged.

Exp. 100.—In order to show the *effect of the addition of water to the above*, the tube and contents were merely washed out with the same, when it *at once assumed an opaque white appearance.* In five to ten minutes, under the microscope, Fibrinous rods and other formations began to manifest themselves, and after two days' exposure to water, the whole had become changed completely into Fibrinous material.

These experiments therefore declare that Oxygen is not the producing cause of this transformation, but Albumen requires first the agency of "moisture," "dilution," or water, to change it into Fibrin before Oxygen can exert any influence upon it of this kind. Afterwards, it seems to endow it with new qualities and a higher state of organization, and gives, as it were, the finishing touch to this important product. Such also appears to be the case in the animal organism. Albumen is transformed into Fibrin by water in the lymphatics and lacteals, &c., and afterwards in the vena cava by water absorbed by the gastric veins, and then its organization is rendered perfect and complete by Respiration. In the animal and vegetable kingdom we observe that the most tiny animalcule or vegetable substance does not start into existence independently of the presence of water. It appears that Fibrin has to be first formed by water before even the germ can exert its living influence upon it and develope a living being, and endow it with its own species and nature. We also notice that fermentation, decomposition, and scarcely any operation in living or dead organic substances can occur without the presence of water. It appears, moreover, that this substance, Fibrin ab Albumen, exactly resembles Fibrin when first formed in the lymphatics. Dr Carpenter has shewn that the latter differs from Blood Fibrin in its inferior tendency to putrefaction (page 180), whence, says he, "it may be inferred that it has not undergone its complete vitalization." This substance also possesses a very low degree of putrefactive tendency, for it remained in water three whole weeks (see Exp. 5), perfectly white and beautiful, as on its first formation, and did not become decomposed for several days afterwards. Oxygen evidently confers upon Fibrin increased attractive and formative qualities; many more rods, &c., presented themselves generally after exposure to the air in most of these experiments.

Exp. 105, 107, 108, 109.—When the cold water was exchanged for that of blood heat, i.e., from 98° to 100° or more Farenheit, no difference was observable in the rapidity or intensity of the transformation.

Mr Smee is said, moreover, to have produced a substance very similar to, if not identical with, Fibrin, "*by feeble currents*

of electricity passed through an albuminous *fluid*, where it accumulates round the positive pole." It appears pretty clear that water was here employed,—by the words "*fluid*" and "*accumulation*" round the pole being used. (See Dr Carpenter's Principles of Physiology, page 56.)

Ov. albumen with the voltaic current.

Exp. 116.—In order to test this experiment more particularly, I employed *ov. albumen alone* between the two platina poles of a voltaic battery of six cells.

I found that there were only a very few small specimens of Fibrin produced under the microscope, but that the albumen, by decomposition and effervescence, became less and less fluid, the Fibrin apparently being transformed by the water of fluidity, —compelled, as it were, by the voltaic current,—and very shortly all transformation ceased. After a time, the albumen became a thickened, and ultimately a solid mass. On examination, it was found to consist almost entirely of unchanged albumen, as the specimen which we have here manifests.

Ov. albumen with water and the voltaic current.

Exp. 110.—I employed *water in this experiment*, and the following, *in conjunction with the voltaic current. In half a minute the albumen became covered with dense and opaque whiteness*, shewing that, in contrast with the other experiments, in which water only was used, the rapidity of transformation was, by electric agency, greatly increased. *Exp.* 112.—The change to dense and opaque white was again effected in about half a minute. With older ov. albumen there is usually an increase in the amount of gas eliminated. Here we had a globule of albumen immersed in water midway between the poles, which was found to be a great advantage. In this experiment I perceived a dense dark brown ring of Fibrin forming around each bubble of gas, which we have preserved, and which can now be seen in the specimen. In fifteen minutes Fibrinous rods were seen shooting forth like the fingers of a human hand (one of the

most beautiful exhibitions I ever witnessed), towards the neg. pole, or in the lines of current.

All these experiments, together with 113 and 115, in which, apparently, thousands of ovoid corpuscles made their appearance, many of which were attracted in beautiful lines, and formed rods, and many of them can still be seen in the specimen, resulted in the formation of perfectly formed Fibrin, without scarcely a vestige of unchanged albumen being left.

Dr Miller declares (page 808) that, when Fibrin is treated with acetic acid under the microscope, it is found to consist of two portions, one of which is granular and soluble in acetic acid, while the other is fibrinous and insoluble. This we found to be a graphic description of what took place with Fibrin ab albumen.

EPITOME OF EXPERIMENTS.

I.—Solution.

Exp. 9 and 69.—*Fibrin ab albumen* dissolved in 3 *min.* in Liq. Potassæ.

Exp. 66.—*Blood Fibrin* was completely dissolved *in twelve hours,* whilst ov. albumen required more than *twenty-four hours* to effect its solution without heat. *Here this substance was much more dissimilar to albumen than even Blood Fibrin itself.*

Exp. 52.—In strong hydrochloric acid, *Fibrin ab albumen and Blood Fibrin both dissolved in twenty-four hours,* whilst ov. albumen was not completely dissolved in sixteen days.

II.—Precipitated Solutions.

In solution in acids precipitated by alkalies—and in alkalies precipitated by acids—*this substance always manifested the same reactions as Blood Fibrin,* and also equally differed from those of albumen. *Exp.* 57 to 63 and 68.

In the Fibrinous solutions precipitated, *we had always Fibrinous rods and formations of Fibrin without the coagulum* peculiar to albumen. In the solutions of albumen precipitated,

we had as *invariably a dense and dark or light coagulum, without Fibrinous rods and formations.*

Moreover, in alkaline solutions of albumen with *acetic acid,* we had always *a dense white and flocculent coagulum;* and when precipitated by *nitric acid,* as stated by Dr Miller,* *a lemon yellow precipitate,* whilst neither coagulum, *nor colour* were present in the precipitates from solution of Fibrin ab albumen, or Blood Fibrin.

The results of these experiments have been so marked, so harmonious, and constant, under the microscope, as to give them a conclusiveness which demands our most serious consideration and attention.

OTHER MODES BY WHICH FIBRIN IS SAID TO HAVE BEEN PRODUCED.

I find that many physiologists who have been reputed to have produced Fibrin, have done so out of dilute solutions, that is, under the influence and agency of water.

Thus Muller produced coagulated Fibrin out of clear, filtered, and, consequently, defibrinated blood serum. But, says he, the blood was diluted with water or with a very thin syrup, 1 part sugar in 200 water." In a few minutes a coagulum formed in the clear liquid after it had passed the filter. But (even then) "this coagulum could not be detected save by drawing it out of the fluid by a needle." "This," says he, "gradually (after a few minutes) contracts, becomes *whitish and fibrous,* and then has exactly the aspect of human lymph." As regards the admixture of two (diseased) serous fluids, such as those of hydrocele and ascites, or ascites and pleurisy, as suggested by Dr Buchanan,† these could take no part in the mode of transformation of albumen into Fibrin, in the absorbments, &c., and are therefore foreign to our present subject.

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* "Organic Chemistry," page iii.

† Dr Carpenter's Physiology, page 242.

Finally, as regards the renowned experiment of Professor Schmidt, who is declared by Dr Carpenter to have attempted to explain the phenomena in question (page 242) by attributing them to the combination of two substances, existing in the Liquor sanguinis, which he has been pleased to denominate "*Globulin*" and "*Fibrinogen.*" That such substances really do exist in the serum or Liquor sanguinis, without Professor Schmidt's interference, is not quite certain any more than that of Mulders' favourite idea of protein existing ready formed in all nitrogenous substances as their primary and basic compound. But if albumen is capable, *per se*, of transformation by any agency, it certainly would be far more simple to discover, first, that direct agency as a solution of the question; rather than to develope two new compounds, and then, by the union of these, to pronounce the source of the phenomena in question. However, Dr Carpenter goes on to say, "both Schmidt and Hoppe Seyler have been successful in producing a coagulum differing in no respect from ordinary Fibrin, by the admixture of these two substances." One might have some difficulty and trepidation in assailing such an explanation of the origin of Fibrin, in the animal organism, as the above, were it not for the great uncertainty that attends all speculations upon matters formed out of the body by chemical decompositions. But when we read on a little further—that both these compounds were precipitated by carbonic acid from *dilute solutions*, all difficulty is at an end. A good deal of *water* must have been employed, and, according to the facts of this paper, the *rationale* is obvious.

It is thus seen that many physiologists, in experimenting upon, and endeavouring to discover the origin and source of, Fibrin in the animal organism, whilst employing other measures which they have supposed capable of effecting this transformation, have been *unwittingly and unsuspectingly making use of the very agent* which alone is capable of developing this important product.

It is rather remarkable how much Leibig insists upon the *presence of water, before oxygen can effect any change in organic substances.* (Organic Chemistry, pages 123 and 111.)

Muller, in his work on Physiology (page 294), declares that

when frogs have been kept out of water for eight or more days, during the summer, their blood often loses the power of coagulation; and, under such circumstances, the lymph taken from the lymph cavities of the same animal affords no coagulum.

Fibrin is formed, therefore, as shown by Dr Carpenter and other Physiologists in the lymphatics, lacteals, absorbent, and mesenteric glands and vascular system,* and we maintain, from the foregoing facts, that this transformation is effected by the agency of water. That this water is drawn from the sanguinious circulation—the great cavities of the body, &c., &c., and from the skin—while at the same time albuminous substances are brought up from the blood vessels and other organs in the shape of effete matter and used-up materials, which, as Dr Carpenter says, are capable of being again assimilated. That these, on meeting with the aqueous fluids, begin at once to undergo a change, and that change is the transformation from Albumen to Fibrin, which he represents as the being subjected to an elaborating or preparatory agency previous to their introduction again into the circulation. This elaboration he speaks of again as being the formation of Fibrin, the assumption of coagulation, and the appearance of a number of chyle or cytoid corpuscles.

We observe, likewise, that the aliment itself is exposed to the action of water, in the shape of all fluids that enter the alimentary canal by imbibition, and afterwards the venous blood (into which the chyle and contents of the absorbents are poured in the union of the subclavian and jugular veins), is also subject to an influx of water, which is drawn from the stomach by the gastric veins.

Here, then, is the admitted presence of the transforming agent at the very point or locality—i.e., in the Lymphatic vessels and glands—where the presence of Fibrin is first detected, and the existing estimated amount of this fluid in the lacteals and lymphatics in comparison with the amount of existing albumen, and at the same time, in comparison with the relative quantities of water and albumen in the blood becomes an important subject of enquiry in this place.

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* Carpenter's Principles of Physiology, page 179-180.